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Viral Templated Palladium Nanocatalysis

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Biological macro/supramolecules such as DNA, proteins, and viruses have gained substantial attention over the past two decades as templates for the synthesis of inorganic materials. A large array of nanometer-scale materials from particles to wires have been synthesized for a variety of applications in nanoelectronics, biomedical imaging, catalysis, and energy. Of particular interest are viruses, which offer attractive templating platforms because their precise dimensions and robust structures can be exploited by genetic manipulation to confer additional functionalities and material-specific adsorption sites.

Our research is mainly focused on exploiting several unique structural, chemical, and biological properties of genetically modified tobacco mosaic virus (TMV) to create templates for nanocatalyst fabrication. Specifically, TMV is a biologically derived nanotube (18 nm diameter, 300 nm length, 4 nm inner channel) that has 2,130 identical coat proteins helically wrapped around a 6.4kb single-strand genomic mRNA. Because of its safety, well-controlled dimensions, and extraordinary stability, TMV has been extensively enlisted for synthesis of nanowires and inorganic nanoparticles. In particular, we harness precisely spaced thiol functionality displayed on the outer surface of each coat protein via a small genetic modification. The modified virus permits facile and readily controllable synthesis of palladium nanoparticles.

In this presentation, we will highlight our recent progress in the fabrication of such nanostructured palladium catalysts and in catalytic reaction studies of direct relevance to environmental remediation. In particular, we are using atomic force microscopy (AFM) and grazing incidence small angle X-ray scattering (GISAXS) to characterize these nanoparticles, with a view to addressing critical challenges in nanocatalysis and to gain fundamental understanding of nanoparticle growth kinetics.